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|---|---|
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# Pearson Edexcel International GCSE (9–1)

## Tuesday 11 November 2025

Morning (Time: 2 hours)

Paper reference **4CH1/1C 4SD0/1C**

# Chemistry

**UNIT: 4CH1**
**Science (Double Award) 4SD0**
**PAPER: 1C**

**You must have:**
Calculator, ruler

Total Marks

## Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- Show all the steps in any calculations and state the units.

## Information

- The total mark for this paper is 110.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

## Advice

- Read each question carefully before you start to answer it.
- Write your answers neatly and in good English.
- Try to answer every question.
- Check your answers if you have time at the end.

*Turn over* ▶

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M:1/1/1/1/1/1/1/1/1/1/1/1

P 7 8 7 6 6 R A 0 1 2 8

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# The Periodic Table of the Elements

| 1 | 2 | | | | | | | | | | | 3 | 4 | 5 | 6 | 7 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 1 H hydrogen 1 | | | | | | | | | | 4 He helium 2 |
| 7 Li lithium 3 | 9 Be beryllium 4 | | | | | | | | | | | 11 B boron 5 | 12 C carbon 6 | 14 N nitrogen 7 | 16 O oxygen 8 | 19 F fluorine 9 | 20 Ne neon 10 |
| 23 Na sodium 11 | 24 Mg magnesium 12 | | | | | | | | | | | 27 Al aluminium 13 | 28 Si silicon 14 | 31 P phosphorus 15 | 32 S sulfur 16 | 35.5 Cl chlorine 17 | 40 Ar argon 18 |
| 39 K potassium 19 | 40 Ca calcium 20 | 45 Sc scandium 21 | 48 Ti titanium 22 | 51 V vanadium 23 | 52 Cr chromium 24 | 55 Mn manganese 25 | 56 Fe iron 26 | 59 Co cobalt 27 | 59 Ni nickel 28 | 63.5 Cu copper 29 | 65 Zn zinc 30 | 70 Ga gallium 31 | 73 Ge germanium 32 | 75 As arsenic 33 | 79 Se selenium 34 | 80 Br bromine 35 | 84 Kr krypton 36 |
| 85 Rb rubidium 37 | 88 Sr strontium 38 | 89 Y yttrium 39 | 91 Zr zirconium 40 | 93 Nb niobium 41 | 96 Mo molybdenum 42 | [98] Tc technetium 43 | 101 Ru ruthenium 44 | 103 Rh rhodium 45 | 106 Pd palladium 46 | 108 Ag silver 47 | 112 Cd cadmium 48 | 115 In indium 49 | 119 Sn tin 50 | 122 Sb antimony 51 | 128 Te tellurium 52 | 127 I iodine 53 | 131 Xe xenon 54 |
| 133 Cs caesium 55 | 137 Ba barium 56 | 139 La* lanthanum 57 | 178 Hf hafnium 72 | 181 Ta tantalum 73 | 184 W tungsten 74 | 186 Re rhenium 75 | 190 Os osmium 76 | 192 Ir iridium 77 | 195 Pt platinum 78 | 197 Au gold 79 | 201 Hg mercury 80 | 204 Tl thallium 81 | 207 Pb lead 82 | 209 Bi bismuth 83 | [209] Po polonium 84 | [210] At astatine 85 | [222] Rn radon 86 |
| [223] Fr francium 87 | [226] Ra radium 88 | [227] Ac* actinium 89 | [261] Rf rutherfordium 104 | [262] Db dubnium 105 | [266] Sg seaborgium 106 | [264] Bh bohrium 107 | [277] Hs hassium 108 | [268] Mt meitnerium 109 | [271] Ds darmstadtium 110 | [272] Rg roentgenium 111 | Elements with atomic numbers 112–116 have been reported but not fully authenticated | | | | | | |

**Key**

relative atomic mass
**atomic symbol**
name
atomic (proton) number

**** The lanthanoids (atomic numbers 58–71) and the actinoids (atomic numbers 90–103) have been omitted.***

***The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.***

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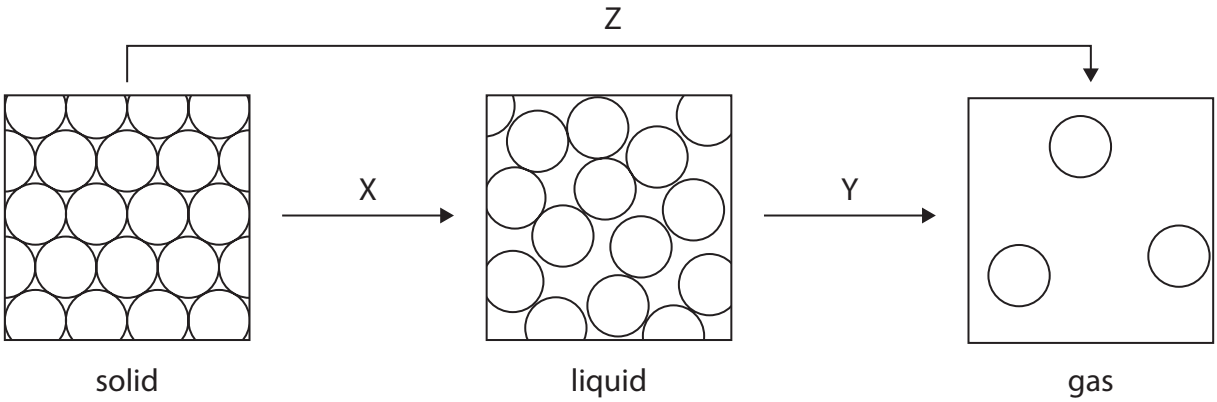
**Answer ALL questions.**

**Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.**

**1** The diagram shows how particles are arranged in the three states of matter.




(a) Give the names of the changes of state labelled X, Y and Z.

**(3)**

X .....

Y .....

Z .....

(b) Water vapour condenses to form water.

Give the equation for this change of state.

Include the state symbols.

**(2)**

.....

(c) Describe how particles are arranged differently in solids and gases.

**(2)**

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**(Total for Question 1 = 7 marks)**

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**2** The box gives the names of some gases in the atmosphere.

| | | |
|---|---|---|
| argon | | carbon dioxide |
| nitrogen | oxygen | water vapour |

(a) Choose gases from the box to answer these questions.

(i) Identify the gas with a molecule that contains a triple bond.

**(1)**

.....

(ii) Identify the gas in the atmosphere that exists as individual atoms.

**(1)**

.....

(iii) Identify the gas needed for combustion reactions.

**(1)**

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(b) Explain how carbon dioxide can be formed from copper(II) carbonate.

**(2)**

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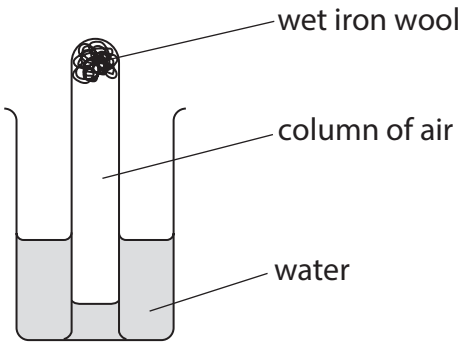
(c) A student uses this apparatus to calculate the percentage of oxygen in a sample of air.




This is the student's method.

- measure the initial height of the column of air
- leave the apparatus for one week
- measure the final height of the column of air

The table shows the student's results.

| | |
|---|---|
| Final height of column of air in mm | 77 |
| Initial height of column of air in mm | 93 |

(i) Use the student's results to calculate the percentage of oxygen in the sample of air.

**(2)**

percentage = ..... %

(ii) The percentage of oxygen in air is approximately 21%.

Suggest an improvement to the method that would increase the accuracy of the student's results.

**(1)**

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**(Total for Question 2 = 8 marks)**

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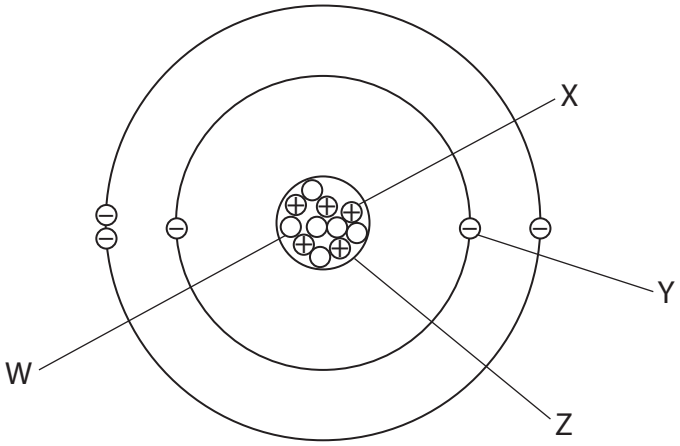
**3** This question is about atomic structure and the Periodic Table.

(a) The diagram shows an atom of an element.




Use the diagram to answer these questions.

(i) Which particle is a proton?

**(1)**

- ☒ **A** W
- ☒ **B** X
- ☒ **C** Y
- ☒ **D** Z

(ii) Which particle has a relative charge of 0?

**(1)**

- ☒ **A** W
- ☒ **B** X
- ☒ **C** Y
- ☒ **D** Z

(iii) Name the part of the atom labelled Z.

**(1)**

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(iv) What is the group number of this element?

**(1)**

- ☒ **A** 2
- ☒ **B** 3
- ☒ **C** 5
- ☒ **D** 11

(v) What is the period number of this element?

**(1)**

- ☒ **A** 2
- ☒ **B** 3
- ☒ **C** 5
- ☒ **D** 11

(vi) Give the chemical symbol of this element.

**(1)**

.....

(b) State what type of particle is formed when an atom loses its outer shell electrons.

**(1)**

.....

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(c) The table shows the atomic number and the relative atomic mass (to 1 decimal place) of the elements in a period of the Periodic Table.

| **Element** | Li | Be | B | C | N | O | F | Ne |
|---|---|---|---|---|---|---|---|---|
| **Atomic number** | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **Relative atomic mass** | 6.9 | 9.0 | 10.8 | 12.0 | 14.0 | 16.0 | 19.0 | 20.2 |

(i) On the grid, add an appropriate scale to the *y*-axis, starting at 6.0

**(1)**

(ii) Plot the data on the grid. Do not join the points.

**(2)**

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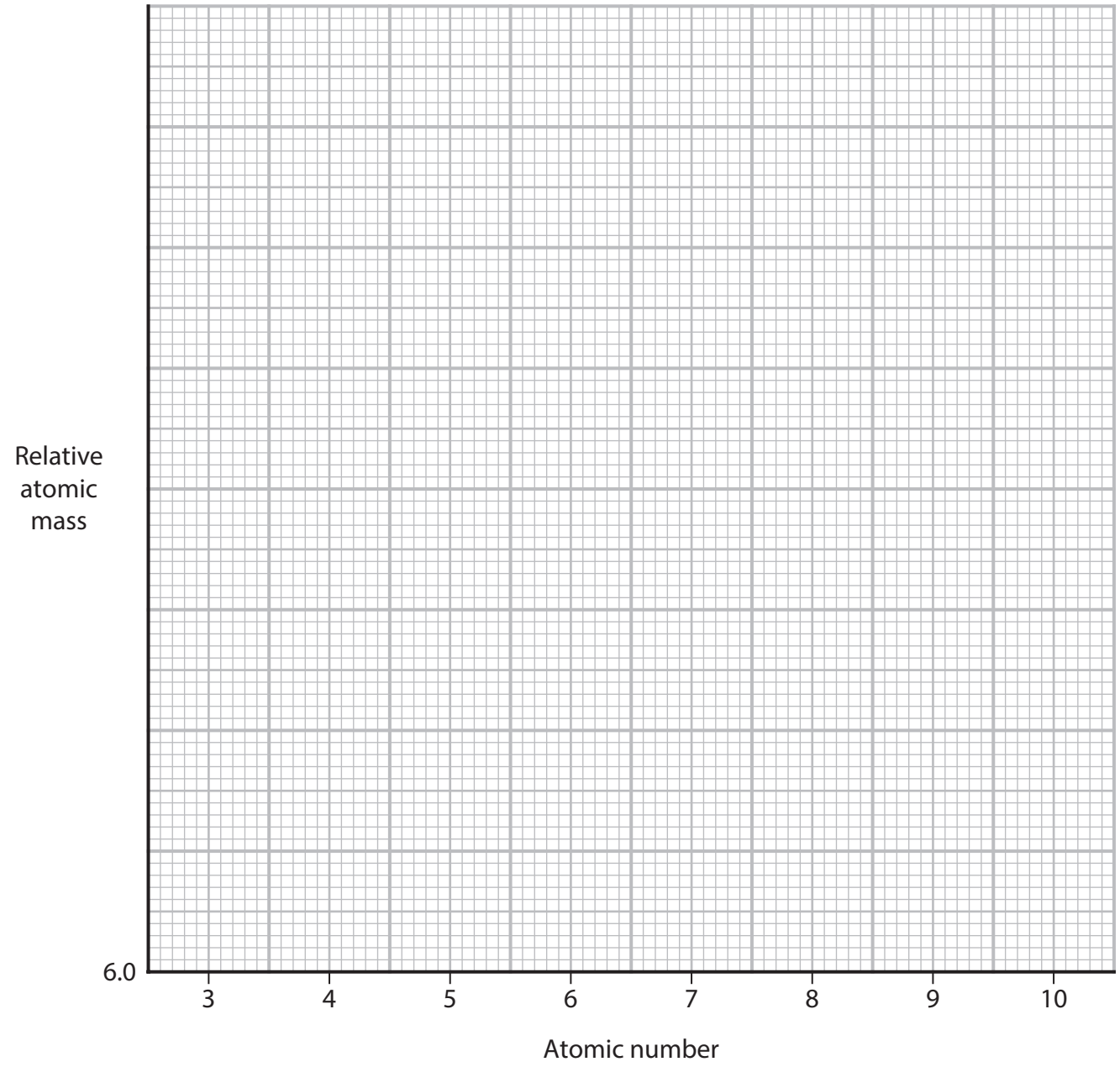


(iii) Identify the relationship between relative atomic mass and atomic number for the elements in this period.

**(1)**

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**(Total for Question 3 = 11 marks)**

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**4** This question is about ammonium chloride.

(a) Draw a diagram to show the arrangement of the electrons in a chloride ion.

**(2)**

(b) Two beakers are unlabelled. One beaker contains a solution of ammonium chloride and the other beaker contains a solution of ammonium sulfate.

Describe tests that can be carried out to confirm that one beaker contains ammonium chloride and the other beaker contains ammonium sulfate.

**(6)**

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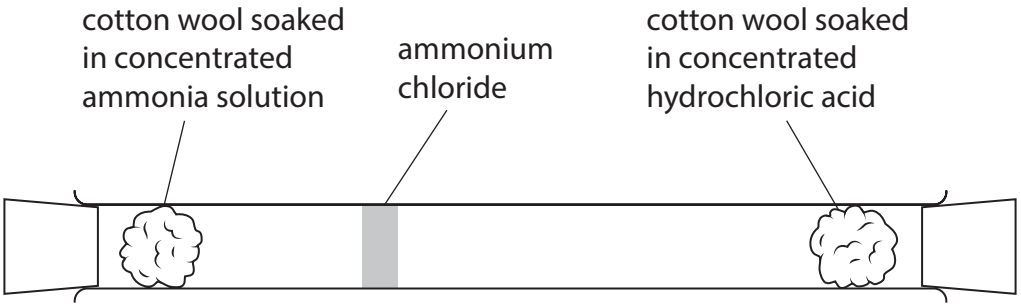
(c) A student draws a diagram to show the formation of solid ammonium chloride in a glass tube.




(i) Explain the mistake in the student's diagram.

**(3)**

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(ii) Complete the equation for the reaction in the glass tube by adding state symbols.

**(1)**

$NH_3$ (.....) + HCl (.....) $\rightleftharpoons$ $NH_4Cl$ (.....)

**(Total for Question 4 = 12 marks)**

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**5** This question is about displacement reactions.

A student uses this method to investigate what happens when excess metal is added to a solution of copper(II) sulfate.

- pour some copper(II) sulfate solution into a polystyrene cup and record the temperature
- add excess metal W to the polystyrene cup and stir the mixture
- record the maximum temperature reached
- calculate the temperature increase of the solution

The student repeats the method for metals X, Y and Z.

For each metal, the student records three sets of results.

(a) Give a reason why the student could not use copper(II) carbonate instead of copper(II) sulfate.

**(1)**

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(b) Explain why a polystyrene cup is used instead of a glass beaker.

**(2)**

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(c) Give two variables the student should control in the investigation.

**(2)**

1 .....

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2 .....

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(d) The table shows the student's results.

| Metal | Temperature increase in °C | | | Mean temperature increase in °C |
|---|---|---|---|---|
| | experiment 1 | experiment 2 | experiment 3 | |
| W | 4.0 | 2.0 | 4.2 | 4.1 |
| X | 0.0 | 0.0 | 0.0 | 0.0 |
| Y | 6.1 | 6.3 | 6.0 | |
| Z | 8.1 | 8.5 | 8.9 | 8.5 |

(i) Calculate the mean temperature increase for metal Y.

Give your answer to two significant figures.

**(2)**

mean temperature increase = ..... °C

(ii) Explain whether the anomalous result in experiment 2 could have been caused by stirring the mixture too quickly.

**(2)**

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(iii) Explain the order of reactivity for metals W, X, Y and Z.

**(2)**

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(iv) Explain why metal X could be silver.

**(2)**

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**(Total for Question 5 = 13 marks)**

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**6** Ethene can be obtained from crude oil using these two processes.

Process 1 crude oil $\rightarrow$ kerosene

Process 2 kerosene $\rightarrow$ octane ($C_8H_{18}$) + ethene

(a) (i) Give the name of process 1.

**(1)**

(ii) Sketch a labelled diagram showing how the kerosene fraction is obtained from crude oil in process 1.

**(5)**

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(b) (i) Give the two conditions needed for a reaction to occur in process 2.

**(2)**

1 .....

2 .....

(ii) Complete the equation for the reaction in process 2.

**(1)**

$C_{14}H_{30} \rightarrow$ ..... + .....

(c) Explain one use of octane as fuel.

**(3)**

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(d) (i) Using displayed formulae, give the equation for the conversion of ethene into poly(ethene).

**(2)**

(ii) Give the term used to describe ethene in the polymerisation process.

**(1)**

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**(Total for Question 6 = 15 marks)**

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**7** A student uses this method to investigate the reaction between sodium hydroxide solution and dilute nitric acid.

Step **1** pour 20 $cm^3$ of dilute nitric acid into a 100 $cm^3$ glass beaker

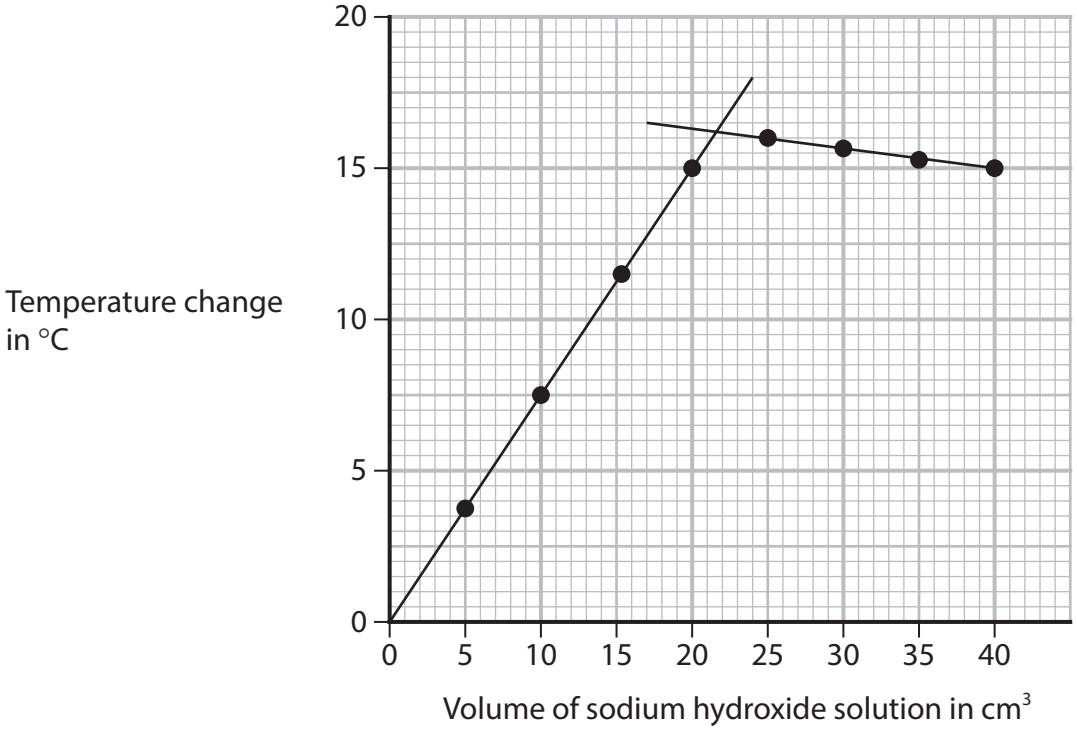
Step **2** measure the temperature of the acid

Step **3** add 5 $cm^3$ of sodium hydroxide solution and stir the mixture

Step **4** record the highest temperature reached

The student repeats steps **3** and **4** until a total of 40 $cm^3$ of sodium hydroxide solution has been added.

(a) The graph shows the student's results.




(i) Determine the volume of sodium hydroxide solution at the point where the lines cross.

**(1)**

volume = ..... $cm^3$

(ii) Determine the maximum temperature change reached during the investigation.

**(1)**

maximum temperature change = ..... °C

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(b) The student makes this statement about the shape of the graph.

*The first line on the graph shows that the temperature rises at a steady rate as more nitric acid is added and at 40 $cm^3$, the acid has been neutralised by the sodium hydroxide.*

The student's statement includes some mistakes and is incomplete.

(i) Give two mistakes in the student's statement.

**(2)**

1 .....

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.....

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2 .....

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(ii) Add another sentence to complete the student's statement.

**(1)**

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(c) The student repeats the investigation.

The student starts with 25 $cm^3$ of dilute nitric acid at 19 °C.

The student finds that 25 $cm^3$ of sodium hydroxide solution is needed for complete neutralisation.

The student calculates that the heat energy ($Q$) released is 3780 J.

[for the solution, $c$ = 4.2 J / g / °C]

[mass for 1.0 $cm^3$ of solution = 1.0 g]

(i) Calculate the maximum temperature reached.

**(4)**

maximum temperature = ..... °C

(ii) The amount of dilute nitric acid used in the investigation was 0.079 mol.

Calculate the value of $\Delta H$, in kJ / mol, for the neutralisation reaction.

Include a sign in your answer.

**(3)**

$\Delta H$ = ..... kJ / mol

**(Total for Question 7 = 12 marks)**

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**8** This question is about ionic compounds.

(a) The table shows the formulae of some ions.

It also shows the formulae of some compounds containing these ions.

Complete the table by giving the missing information.

**(3)**

| **Ions** | $Li^+$ | $Mg^{2+}$ | $Al^{3+}$ |
|---|---|---|---|
| $NO_3^-$ | $LiNO_3$ | | $Al(NO_3)_3$ |
| $SO_4^{2-}$ | | $MgSO_4$ | $Al_2(SO_4)_3$ |
| $PO_4^{3-}$ | $Li_3PO_4$ | $Mg_3(PO_4)_2$ | |

(b) Explain why magnesium oxide has a higher melting point than sodium chloride.

Refer to structure and bonding in your answer.

**(5)**

**(Total for Question 8 = 8 marks)**

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**9** This question is about propene and propane.

(a) Complete the table by giving the missing information about **propene**.

**(3)**

| | |
|---|---|
| Displayed formula of propene | |
| Molecular formula of propene | $C_3H_6$ |
| Empirical formula of propene | |
| Relative formula mass of propene | |

(b) Draw a dot-and-cross diagram for **propane**.

Include only outer shell electrons.

**(2)**

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(c) Propene and propane react with bromine.

(i) Which row shows the correct number of products for these reactions?

**(1)**

| | | Propene and bromine | Propane and bromine |
|---|---|---|---|
| ☒ | **A** | 1 | 1 |
| ☒ | **B** | 1 | 2 |
| ☒ | **C** | 2 | 1 |
| ☒ | **D** | 2 | 2 |

(ii) Give the reaction condition needed for propane and bromine to react together.

**(1)**

.....

(iii) A compound formed in the reaction between bromine water and an alkene has this percentage composition by mass.

C = 25.9% H = 5.0% O = 11.5% Br = 57.6%

Calculate the empirical formula of this compound.

**(3)**

empirical formula = .....

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(d) Ethene and propene contain the same functional group.

(i) State what is meant by the term **functional group**.

**(1)**

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.....

(ii) Draw an isomer of propene that does not have the same functional group.

**(1)**

**(Total for Question 9 = 12 marks)**

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**10** This question is about aluminium sulfate.

Aluminium reacts with sulfuric acid to form aluminium sulfate.

This is the equation for the reaction.

$$2Al + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2$$

(a) What is the total number of elements in the formula $Al_2(SO_4)_3$?

**(1)**

- ☒ **A** 3
- ☒ **B** 5
- ☒ **C** 14
- ☒ **D** 17

(b) A student uses this method to prepare some aluminium sulfate crystals.

Step **1** add powdered aluminium to a beaker of dilute sulfuric acid and stir

Step **2** keep stirring and adding powdered aluminium until it is in excess

Step **3** filter the reaction mixture

Step **4** heat the filtrate to evaporate some water and produce a saturated solution

Step **5** allow the saturated solution to cool so that crystals form

Step **6** filter to obtain the crystals and leave to dry

(i) During step 3, the reaction mixture is filtered.

Identify the substance that remains in the filter paper and the substances in the beaker after this filtration.

**(2)**

filter paper

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beaker

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(ii) State why the aluminium is added until it is in excess.

**(1)**

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.....

(iii) Explain why powdered aluminium is used.

**(2)**

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**Question 10 continues on the next page**

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(c) The student adds 3.20 g of aluminium to 0.120 mol of dilute sulfuric acid.

(i) Show that sulfuric acid is not in excess.

**(2)**

(ii) The student calculates the percentage yield of aluminium sulfate obtained from 0.120 mol of sulfuric acid as 113%.

Calculate the mass, in grams, of aluminium sulfate produced if the yield is 113%.

**(3)**

mass = ..... g

(iii) Suggest a mistake the student made when carrying out the method that caused the percentage yield to be greater than 100%.

**(1)**

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**(Total for Question 10 = 12 marks)**

**TOTAL FOR PAPER = 110 MARKS**

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